Effect of carbofuran on transformation of urea nitrogen in soil

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ABSTRACT

THE effect of Carbofuran at 10 and 50 ppm of soil on transformation of urea nitrogen in a sandy loam (pH 7-7) was studied in laboratory. The insecticide had no effect on urea hydrolysis but moderately inhibited both conversion of NH_4^+ to NO_2^- and NO_2^- to NO_3^-, the effect being pronounced at the higher rate but lasted upto 2 weeks only. The results of the study along with other evidences suggest that under normal field application rates, carbofuran may have little effect on the hydrolysis as well as nitrification of urea nitrogen in soils with pH in the alkaline range.

INTRODUCTION

In modern agriculture the use of pest control chemicals have become more common with the result large amounts of pesticides find place to soils either through direct application or from the above ground pest control practices. These agricultural chemicals used for pest management are also known to have effects on certain biochemical transformations like mineralization and nitrification in Soils (Parr, 1974; Sahrawat, 1974; Tu and Miles, 1976), which may affect the availability of nitrogen and other plant nutrients and plant growth (Sahrawat, 1975, 1976).

Carbofuran is an important insecticide having a wide usage for the control of insect pests of various crops through soil or foliar application. The persistence and degradation of carbofuran in soils have been investicated by Getzin (1973). However, there is lack of information about the effects of carbofuran application on the transformations of nitrogen in soils particularly urea hydrolysis and its subsequent nitrification in soil. The objective of the work reported here was to evaluate the effects of this insecticide on transformations of urea nitrogen in soil.

MATERIALS AND METHODS

The soil used was a surface (0-15 cm) sample of a sandy clay loam, alluvial soil, collected from the farm of the Indian Agricultural Research Institute, New Delhi. Before use the soil was air dried and ground to pass a 2-mm sieve. The important properties of the soil are given in Table 1.

Technically pure carbofuran (2, 3-dihydro-2, 2-dimethyl-7-benzofuranyl N-methyl carbomate), a product of F.M.C. Corporation, N.Y., was used in this study for testing its effects on hydrolysis and nitrification of urea in soil at concentrations of 10 and 50 ppm of soil.

Incubation Procedure: Soil samples (100 g) were placed in 500 ml beakers and treated with 5 ml of water containing 10 mg of nitrogen as urea. Carbofuran was also applied through aqueous solutions containing 1 or 5 mg of the insecticide to give final concentrations of 10 or 50 μg/g of soil. Carbofuran and urea in solutions were first mixed together and then applied to the soil samples and properly mixed. The moisture contents of the soil samples were adjusted to 60% water holding capacity. The beakers were then covered with polythene sheets and incubated at room temperature (mean 30°C; maximum 37°C and minimum 23°C) for 6 weeks. Loss of water due to evaporation during incubation was made up regularly by adding distilled water.

Duplicate representative 10 g soil samples were drawn from each treatments and analyzed weekly for urea nitrogen (Douglas and Bremner, 1970) and for NH^+_4, NO_2^- and NO_3^- N (Sahrawat and Prasad, 1975). From the values of NO_2^- and NO_3^-, the percentage inhibition of nitrification by carbofuran was

TABLE 1. — PROPERTIES OF THE SOIL USED

Properties	*Value*
pH (1.25)	7.7
Organic cabon (%)	0.60
Total N (%)	0.07
Ammoniacal N (ppm)	6
Nitrate N (ppm)	10
Nitrite N (ppm)	0.0
Sand (%)	61
Silt (%)	15
Clay	24
Cation exchange capacity (m.e./100 g oil)	11.6
Water holding capacity (%)	38.4

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TABLE 2 — EFFECT OF CARBOFURAN ON TRANSFORMATION OF UREA N IN SOIL*

Carbofuran Concentration (µg/g of soil)		*Parts/10⁶ of inorganic nitrogen after weeks of incubation*					
		1	2	3	4	5	6
0	NH_4^+	76	50	31	22	10	7
	NO_2^-	5.2	3.6	2.0	1.4	0.0	0.0
	NO_3^-	16	40	55	71	80	89
10	NH_4^+	79	56	35	23	10	8
	NO_2^-	7.6	9.1	7.8	4.0	1.5	0.8
	NO_3^-	12	31	48	61	78	88
50	NH_4^+	84	63	43	24	14	8
	NO_2^-	10.9	13.0	10.2	4.8	2.8	1.5
	NO_3^-	7	23	44	66	76	87

* *No urea N could be detected in any of the treatments with or without carbouran after 1 week of incubation. About 11 ppm of urea N was found in all treatments after 4 days of incubation.*

calculated as described by Bundy and Bremer (1973). Using the formula (C-S)/C x 100 where S = amount of (NO_2^- + NO_3^-)-N produced in soil samples treated with carbofuran and C = amount of (NO_2^- + NO_3^-)-N produced in the untreated control (no carbofuran added).

RESULTS AND DISCUSSION

Results on the effect of carbofuran on transformations of urea N are shown in Table 2.

No urea N was detected in the soil samples under all treatment after 1 week of incubation with or without carbofuran, indicating that urea hydrolysis was not affected by the insecticide application. Urea hydrolysis was quite rapid and was complete by one week in the soil, which corroborates my earlier findings (Sahrawat, 1977).

The insecticide retarded nitrification moderately at 50 ppm concentration and the effect was negligible at 10 ppm. Both steps of nitrification viz., conversion of NH_4^+ to NO_2^- and of NO_2^- to NO_3^- were checked moderately upto 2 weeks only as indicated by results in Tables 2 and 3. The inhibition of conversion of NO_2^- to NO_3^- resulted in accumulation of higher amounts of NO_2^--N in soil samples treated with carbofuran specially at 50 ppm concentration (Table 2). The highest amount of NO_2^- detected in urea treated soil samples was only 5.2 ppm, which was increased to 13.0 ppm NO_2^- due to carbofuran application at 50 ppm concentration. Also it was further indicated by the results shown in Table 3 that the inhibition of nitrification observed by marbofuran application maximally lasted upto 2 weeks. The maximum inhibition of nitrification of urea N was 18% after 2 weeks with 50 ppm concentration of carbofuran, which fell down to 5% only after 3 weeks of incubation.

TABLE 3. — EFFECT OF CARBOFURAN FICATION OF UREA N.

Carbofuran Concentration (µg/g of soil)	*% inhibition of nitrification after weeks of incubation*			
	1	2	3	4
10	5	9	2	1
50	14	18	5	1

The inhibition of nitrification with carbofuran application at both rates (10 and 50 ppm) appeared to last upto 2 weeks in the soil studied. This might be possibly due to rapid chemical hydrolysis of carbofuran in this soil with an alkaline reaction of 7.7. The support for this conclusion has been provided by the study of Getzin (1973), who observed that the degradation of carbofuran was 7-10 times faster in an alkaline soil (pH 7.9) than in acid and neutral soils (pH 4.3 — 6.8).

The results of the present study indicate that carbofuran may not influence urea hydrolysis. Also work reported here along with the observations made by Getzin (1973) suggest that the field rates of carbofuran application will have little effect, if any on the nitrification process in soils having pH in the alkaline range.

In conclusion, the work reported suggests that carbofuran application may be of little consequences as far as urea hydrolysis or nitrification are concerned in the soil studied.

REFERENCES

1. Bundy. L. G., and Bremner, J. M. (1973). Inhibition of nitrification in soils. Soil Sci. Soc. Amer. Proc. *37*: 396-398.
2. Douglas, L. A., and Bremner, J. M. (1970). Extraction and colorimetric determination of urea in soils. Soil Sci. Soc. Amer. Proc. *34*: 859-862.
3. Getzin, L. W. (1973). Persistence and degradation of carbofuran in soil. Environ. Entomol. 2: 461-467.
4. Parr, J. F. (1974). Effects of pesticides on microorganisms in soil and water. In *Pesticides in soil and water* (W. D. Guenzi, Ed.) Soil Sci. Soc. of Amer., Madison, Wisconsin.
5. Sahrawat, K. L. (1974). Effect of pesticides on nitrification Pesticides *8* (12): 30-33.
6. Sahrawat, K. L. (1975). Effect of pesticides on nitrogen fixation. Pesticides *9* (6): 21-23.
7. Sahrawat, K. L. (1976). Effect of pesticides on availability of plant nutrients, Pesticides *10* (12): 15-18.
8. Sahrawat, K. L. (1977). Effect of biuret content on transformation of urea nitrogen in soil. Soil Biol. Biochem. *9*: 173-175.
9. Sahrawat, K. L., and Prasad, R. 1975). A rapid method for determination of nitrate, nitrite and ammoniacal nitrogen in soils. Plant Soil *42*: 305-308.
10. Tu, C. M., and Miles, J.R.W. (1976). Interaction between insecticides and soil microbes. Residue Reviews *64*: 17-65.